

AMENDMENT TO THE CLAIMS

Please replace the pending claims with the following amended claims:

1. (Currently Amended) A biaxial piezoelectric motor comprising:

a contact element, the contact element to include at least one point to contact an object to be moved;

a first piezoelectric driver coupled to one side of the contact element, when energized, the first piezoelectric driver to move the object in a first direction approximately tangential to the surface of the contact element at the at least one point of contact; and,

a second piezoelectric driver coupled to a second side of the contact element, the piezoelectric to move the object in a second direction approximately tangential to the surface of the contact element at the at least one point of contact, the first direction and the second direction to form an angle other than 180 degrees to enable movement of the object in a two dimensional plane.

2. (Original) The biaxial piezoelectric motor of claim 1 wherein the contact element is hemispherical in shape.

3. (Original) The biaxial piezoelectric motor of claim 1 wherein the first direction and the second direction are orthogonal.

4. (Currently amended) ~~The A biaxial piezoelectric motor of claim 1 further comprising:~~

a contact element, the contact element to include at least one point to contact an object to be moved;

a first piezoelectric driver coupled to one side of the contact element, when energized, the first piezoelectric driver to move the object in a first direction;

a second piezoelectric driver coupled to a second side of the contact element, the piezoelectric to move the object in a second direction, the first direction

and the second direction to form an angle other than 180 degrees to enable movement of the object in a two dimensional plane; and,

a third piezoelectric driver coupled to the contact element, the third piezoelectric driver in combination with the first piezoelectric driver and the second piezoelectric driver to enable movement of the object in every direction in a plane.

5. (Original) The biaxial piezoelectric motor of claim 4 further comprising:
a fourth piezoelectric driver coupled to the contact element.

6. (Original) The biaxial piezoelectric motor of claim 1 further comprising:
drive circuitry coupled to the first piezoelectric driver and the second piezoelectric driver, the drive circuitry to determine a desired direction and amplitude of motion for the object, the drive circuitry including a processor that computes the voltage amplitude applied to the first piezoelectric and the voltage amplitude applied to the second piezoelectric to move the object in the desired direction.

7. (Original) The biaxial piezoelectric motor of claim 6 wherein the amplitude of motion for the object is controlled by adjusting the frequency of the first piezoelectric with respect to the frequency of the second piezoelectric, a higher frequency representing an increase in amplitude of motion for the object.

8. (Original) The biaxial piezoelectric motor of claim 6 wherein the ratio of voltage amplitude applied to the first piezoelectric driver to the voltage amplitude applied to the second piezoelectric driver is equal to the ratio of the cosine of the angle formed between the desired direction and the first direction and the cosine of the angle between the desired direction and the second direction.

9. (Original) The biaxial piezoelectric motor of claim 8 wherein the ratio of amplitude of motion for the object is a ratio of frequency applied to the first piezoelectric driver to the frequency applied to the second piezoelectric driver.

10. (Original) The biaxial piezoelectric motor of claim 6 further comprising:
a sensor to determine the position of the object and to provide feedback to the drive circuitry.

11. (Original) The biaxial piezoelectric motor of claim 6 wherein the drive circuitry and the contact elements are mounted on PCB boards.

12. (Original) The biaxial piezoelectric motor of claim 11 wherein the PCB is ceramic with conducting traces.

13. (Original) The biaxial piezoelectric motor of claim 1 wherein the contact element interacts with an opposite surface to increase friction on the object to be moved.

14. (Original) The biaxial piezoelectric motor of claim 13 wherein the opposite surface is a second biaxial piezoelectric motor.

15. (Original) The biaxial piezoelectric motor of claim 13 wherein the opposite surface is a ball bearing.

16. (Original) The biaxial piezoelectric motor of claim 1 wherein a transfer element is interposed between the contact element and the object to be moved.

17. (Original) The biaxial piezoelectric motor of claim 16 wherein the contact transfer element is a sphere, the sphere to convert stick slip motion to a rotary motion.

18. (Original) The biaxial piezoelectric motor of claim 17 wherein the sphere consists of one of a metal, a plastic, or a ceramic.

19. (Original) The biaxial piezoelectric motor of claim 17 wherein the sphere is coated with a thin layer.

20. (Original) The biaxial piezoelectric motor of claim 1 wherein the contact element contacts the object to be moved at only one point.

21. (Original) The biaxial piezoelectric motor of claim 1 wherein the output of each piezoelectric is a high frequency where the wavelength is shorter than the size of the contact element.

22. (Currently Amended) The biaxial piezoelectric motor of claim 21 wherein the an interface between the piezoelectrics and the contact element is-are in a single plane parallel to the two dimensional plane in which the object moves.

23. (Original) The biaxial piezoelectric motor of claim 1 wherein the biaxial piezoelectric motor is directly bonded to a PCB board.

24. (Original) The biaxial piezoelectric motor of claim 1 wherein the contact is coated with a thin coating.

25. (Original) The biaxial piezoelectric motor of claim 1 wherein the contact is textured to impart additional lateral motion to the object.

26. (Currently Amended) A biaxial piezoelectric motor comprising:
- a transfer element;
- a first contact element driven by a first piezoelectric, the contact element coupled to a first point on the transfer element to move the transfer element in a first direction;
- a second contact element driven by a second piezoelectric, the second contact coupled to a second point on the transfer element to move the transfer element in a second direction; ~~and, the first direction and the second direction to form an angle other than 180 degrees~~
- the transfer element including a surface to couple to an object to be moved, the transfer element to move the object in at least three degrees of freedom in a plane approximately tangential to the surface of the transfer element where the transfer element contacts the object to be moved.

(Cancelled – Second version of Claim 26)

27. (Original) The biaxial piezoelectric motor of claim 26 wherein the transfer element is spherical.

28 (Original) The biaxial piezoelectric motor of claim 25 wherein the first direction and the second direction is orthogonal.

29. (Original) The biaxial piezoelectric motor of claim 25 further comprising:

a third contact element coupled to a third piezoelectric, the third contact element in combination with the third piezoelectric to enable movement of the object in every direction in a plane.

30-34. (Cancelled)

35. (New) A plurality of biaxial motors to move an object comprising at least:
 - a first biaxial piezoelectric motor including a first piezoelectric driver coupled to one side of a contact element, when energized, the first piezoelectric driver to move the object in a first direction approximately tangential to the at least one point of contact, the first biaxial piezoelectric motor further including a second piezoelectric driver coupled to a second side of the contact element, the second piezoelectric to move the object in a second direction approximately tangential to the at least one point of contact, the first direction and the second direction to form an angle other than 180 degrees to enable movement of the object in a two dimensional plane; and,
 - a second biaxial piezoelectric motor including a corresponding first piezoelectric driver of the second biaxial piezoelectric motor, the corresponding first driver coupled to one side of a second contact element, when energized, the corresponding first piezoelectric driver to move the object in a third direction, the second biaxial piezoelectric motor further including a corresponding second piezoelectric driver of the second biaxial piezoelectric motor coupled to a second side of the second contact element, the corresponding second piezoelectric to move the object in a fourth direction.
36. (New) The plurality of biaxial motors of claim 35 wherein the first contact element interacts with a third biaxial piezoelectric motor positioned on an opposite surface of the object to be moved.
37. (New) The plurality of biaxial motors of claim 35 further comprising a third biaxial motor.
38. (New) The plurality of biaxial motors of claim 35 wherein the first biaxial motor and the second biaxial motor working together enable rotation of the object.

39. (New) A biaxial piezoelectric motor comprising:

a contact element, the contact element to include at least one point to contact an object to be moved;

a first piezoelectric driver coupled to one side of the contact element, when energized, the first piezoelectric driver to move the object in a first lateral direction; and,

a second piezoelectric driver coupled to a second side of the contact element, the piezoelectric to move the object in a second lateral direction, the first lateral direction and the second lateral direction oriented such that the object can be moved with at least two degrees of freedom in a two dimensional plane oriented approximately tangent to the surface of the contact element where the contact element contacts the object to be moved.

40. (New) The biaxial piezoelectric motor of claim 25 wherein the direction of motion of the transfer element is rotational.